CHAPTER 2

RELIABILITY ISSUES

Introduction

Several unique characteristics distinguish the electrical utility industry from other industries. These characteristics have significant implications for maintaining reliability in a restructured environment and must be given specific consideration in the development of a competitive model. Some of the more important characteristics are as follows:

- electricity must usually be generated at the same time that it is consumed since storing electricity is difficult and expensive;
- electricity consumption varies widely depending on the time of day and the season;
- electricity moves at the speed of light and many operational decisions must be made and implemented very quickly or automatically;
- changes anywhere in the interconnected electrical system impact all other points of the system;
- electric system conditions are constantly changing with changes in load, generation and transmission line configurations;
- the addition of new electric infrastructure (generating units and transmission lines) is capital intensive and subject to long lead times; and
- a reliable supply of electricity is vital to certain essential human needs.

As a result of these attributes, the interconnected electric system represents, in many respects, a communal property which must be operated in a coordinated manner. In other words, individual problems within an individual electrical system can impact a larger interconnected system if certain safeguards and restrictions are not developed and formalized.

The industry is also characterized by vertically integrated utilities that have historically owned and operated generation, transmission, and distribution facilities. These individually owned utility systems have been connected together to form the interconnected electrical grid. This system which has developed over decades of vertical integration is generally built around large central station generating facilities that are located in remote areas[16] and high voltage transmission lines which were primarily designed to transmit power from remote areas to load centers.

A secondary function of these lines has been to facilitate transfers of energy from one control area to another during periods of emergency or in response to economic advantages that can be captured as a result of load diversity between utility systems. As such, the interconnected electrical grid is often constrained and not ideally suited to massive movements of power between regions. These transmission constraints effectively limit competition among suppliers since substantial levels of generation are often required within specific geographic regions (control areas) to maintain reliability when sufficient supplies cannot be imported. The required level of local generation varies as system conditions (load, unit dispatch, transmission configurations, etc.) change. This means that local generators may face little competition at certain times.

Most, if not all, restructuring plans provide for the functional separation of generation, transmission and distribution. These plans tend to defer consideration of many of the complications imposed by unbundling until the plans are actually being implemented. Since few restructuring plans have actually been fully implemented (none in the US), there are many unresolved issues. One complication is that there is no clear delineation between the various functions. The separation of generation and transmission is particularly problematic since the two functions are substitutable in many respects. It should also be noted that generating unit dispatch is one the most effective ways of controlling transmission line loadings.[17] The separation of generation, transmission and distribution may also have indirect reliability implications in that such unbundling may fundamentally alter the respective oversight authorities of state and federal regulatory authorities. This is further complicated by the lack of a clear delineation between distribution and transmission facilities.

This chapter of the report will identify and discuss reliability issues as they relate to generation, transmission, the separation of transmission and generation, the jurisdictional implications of unbundling, and distribution.

Generation

One major uncertainty in the restructuring debate is whether competitive markets will produce sufficient generating reserves in a timely manner. Such reserves are necessary due to lengthy construction lead times for new generation and for maintaining adequate supplies during periods of extended generating unit outages, unexpected loads, etc.

Many restructuring proponents argue that competition will stimulate new investments and technologies which will enhance our electrical reserves. These same proponents often argue that competition will also serve to reduce electrical costs to the short-run marginal cost of producing electricity (i.e. energy costs, variable maintenance costs, etc.). These two arguments are difficult to reconcile since developers and entrepreneurs will seek to earn returns on their investments and such returns will be difficult to obtain with lower electrical prices. These two statements can only be reconciled if the total costs of building new generating units (fixed costs plus variable operating costs) are less than the variable costs of existing generating units. Variable generating costs are generally low in Virginia and the surrounding region. Consequently, new units may be unable to compete during all but a few peak hours when short-run marginal costs are higher if competition does in fact drive prices to marginal production costs. Reserves will decline under such a scenario unless capacity constraints drive electrical prices upward and unit additions are stimulated. Given the long construction lead times and high capital requirements of constructing new generating facilities, entrepreneurs may be reluctant to develop new generating facilities unless they expect sustained periods of higher prices. Consequently, strict reliance on market forces may result in cyclical reserves with periodic shortages followed by excess supplies.

The adequacy of our generating reserves may not be a problem if competitive prices can provide consumers with improved price signals which produce load reductions in a timely manner. Such an approach, however, is problematic in several respects. First, prices would likely have to be very volatile in order to achieve such a result. Such volatility may not be acceptable to smaller customers and many consumers would likely seek to avoid price volatility through hedging or other means. Consequently, it may be very difficult to provide consumers with price signals that would produce short term load reductions during constrained periods.

Second, many customers may have a limited ability to receive and respond to price signals in the short run and in some instances even in the long run. For example, residential heating customers may not have alternative sources of heat in the event that cold weather causes an increase in spot energy prices. These customers would be forced to either pay higher spot prices if peak pricing signals were in place or simply do without electricity in the short run. These customers could conceivably install alternative heating systems or switch to some other fuel in the long run. However, many low income customers may not have the wherewithal to make such an investment. Similar problems could occur during summer peak periods and customers may suffer to an even greater extent since there are few substitutes for electric air conditioning. It should be noted that larger more sophisticated customers may have the ability to respond to higher peak pricing and to reduce load during constrained periods. Available generating reserves may be adequate if there is sufficient response from these customers. However, continued load growth associated with smaller, less responsive customers could ultimately create a reserve deficiency. Finally, strict reliance on interactions between supply and demand could result in direct bidding for constrained supplies where available supplies would essentially go to the highest bidder. This may be undesirable from a social perspective.

A recent article published in The Electricity Journal summarizes the concerns associated with the adequacy of capacity in a competitive electricity market by concluding:

> *The conclusion that competition is appropriate for generation markets does not eliminate the need for government to determine the best set of institutional arrangements for the electricity market. The continued possibility of non-market clearing situations in real-time electrical systems implies that there is a positive social externality associated with the construction of capacity or reduction in peak load. In principle, this externality can be internalized either by a system of tradable capacity obligations or by a capacity subsidy. In practice, a host of implementation issues needs to be resolved. In particular, either system ought to be based on an attempt to establish the marginal social benefit associated with the capacity externality.*
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> *The world is full of competitive markets upon which particular requirements have been imposed by government to make the market work more efficiently. When oil price regulation was eliminated in the United States, we saw no need to eliminate policies that encourage and, in some cases, force unitization of oil fields. When banking was deregulated, we did not eliminate minimum capital requirements for banks. Similarly, there is no logical connection between deregulation of electricity prices and capacity responsibilities. The policy debate should be focused on*
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> *determining the optimal level of reliability and the most efficient mechanisms for achieving it, rather than on whether reliability is a public policy concern.*[18]

As noted in the above article, there are a number of methods by which additional incentives can be provided to assure that capacity resources are adequate. For example, some competitive models provide for capacity payment additions to spot electrical prices. Such methods can, however, create inequities and greatly undermine the potential for competitive benefits if structured improperly or implemented poorly.

If it is determined that additional measures, such as capacity adders or mandated capacity reserve requirements, are needed to assure reliability in a competitive electricity market, jurisdictional and equity considerations may dictate certain models or market structures. As previously mentioned, one important consideration that must be kept in mind is the communal aspects of our electrical system. Improperly structured models may provide certain customers with opportunities to avoid mandated reserve requirements or capacity adders and allow those customers to take advantage of reliability measures that are being provided by other customers.

Wholesale customers and/or suppliers can currently rely on reserves being provided for retail customers to backstop their supply contracts. Consequently they can enter into firm transactions that do not have dedicated capacity supplies commensurate with the level of supply commitments that are embodied in those contracts.

Retail models could result in similar problems if structured in certain ways. For example, a retail model that allows bilateral supply contracts in conjunction with a poolco could produce a similar situation if the poolco provides for capacity reserves and bilateral customers are allowed to purchase backup supplies from the poolco on an as needed basis. Reliability could suffer under such a scenario since

customers will be reluctant to continue supporting reliability measures if they can rely on system precautions that are being paid for by others.

In short, inconsistent requirements could result in a "death spiral" of sorts where fewer and fewer customers are willing to fund reliability measures. The Electricity Consumers Resource Council (ELCON) seems to recognize this concern and notes:

> *Bulk-power reliability is primarily a commons issue. Individual customers generally cannot select their desired level of bulk-power reliability. However, individual customers can sell certain services (e.g., interruption rights with "call options") to the ISO that help maintain reliability at appropriate levels....*[19]

Some states have indicated that they will assure adequate reserves by placing requirements for reserve capacity on suppliers who are doing business within those states. Reserve requirements would presumably be imposed in conjunction with supplier certification or registration requirements. Such an approach may be very difficult to administer and/or enforce since state regulators may be unable to verify that reserves are in fact available for specific transactions. In other words, it could be difficult to prevent the same reserves from being sold several times if they exist at all. Reserve requirements may also limit competition by discouraging potential suppliers from competing in markets where reserve requirements have been imposed.

A competitive generation market may influence the type of generating units that are added since competitive concerns will encourage entrepreneurs to seek a quicker return on their investments. This could mean that units with higher capital costs and longer construction lead times, such as coal units, are less likely to be built. This may have reliability implications in that there could be a greater reliance on natural gas and less fuel diversity. While this may not be a concern from a natural gas production perspective, it could be a concern from a gas infrastructure perspective. For example, natural gas pipeline capacity in central and eastern Virginia is constrained. New gas fired generating facilities may be less likely to locate in this area due to gas supply limitations and the costs associated with relieving those constraints.

Transmission

The unbundling of high voltage transmission services is a prerequisite for competition among electrical suppliers. This was recognized in FERC Order No. 888[20] where the FERC attempted to stimulate wholesale competition by requiring that utilities offer open access transmission services. This unbundling of transmission has given rise to new operational complexities for the interconnected grid. These complexities are generally associated with the fact that financial transactions do not typically reflect actual physical flows of electricity. For example, bulk power transactions are generally based on fixed "contract paths" which do not vary with ongoing changes in physical electrical conditions. " Contract path" arrangements are established individually on an assumed set of conditions. Such assumptions include static electric loads, fixed levels of generation from specific generating units and fixed transmission configurations. These conditions are constantly changing since load is never static, generation sources change frequently, and transmission configurations are often modified as a result of transmission line outages and changes in generation. Consequently, actual power flows differ dramatically from their assumed " contract path."

These differences can result in increased power flows on utility systems that are not directly involved in the " contract path" transaction. Increased flows, which are typically referred to as loop or parallel path flows, can result in an overload of transmission facilities. In other words, virtually all power supply transactions can impose

actual flows on a third party utility system and can potentially jeopardize the reliability of that system without providing any compensation to that third party.

The interconnection of electrical facilities also means that a failure or overload of a specific transmission line can result in the rapid, almost instantaneous, failure of connected facilities. Consequently, the electrical grid is operated in a manner that is intended to prevent a cascading outage from being triggered by a single contingency. This means that utility operators frequently take steps to relieve flows on critical transmission facilities that are approaching their physical limits in anticipation of potential contingencies. Parallel or loop flows greatly complicate this process since utility operators must, in most instances, evaluate outside conditions (generator dispatch, scheduled power flow transactions and grid configurations of other utilities) in order to identify potential problems and rely on other utility operators to take corrective action once potential problems are identified. This complexity is compounded by the fact that wholesale competition has increased, and will likely continue to increase, the number of power flow transactions.

Retail competition would likely increase the number of transactions to an even greater level. The increase in the number of transactions is illustrated by recent statements made by a Southern Company executive who indicated that the rising volume and volatility of transactions from outside Southern's system were threatening reliability. These transactions were not scheduled or anticipated by Southern's operators.[21]

A failure to anticipate loop flows and a lack of coordination among utility operators can significantly impact the reliability of the bulk power system. This is evidenced by two major outages that were experienced in the western interconnected electrical grid last year. These outages impacted millions of customers located in a number of western states, Canada and Mexico.

The first of these two outages which occurred on July 2-3, 1996, was initiated by a short circuit caused by a tree that was growing too close to the line. This problem, which could have been isolated under normal conditions, quickly cascaded across a much larger region. Operating precautions against such a cascading failure proved inadequate due to a number of reasons including unusually high transmission loadings associated with movements of power between regions during peak periods. The second outage, which occurred on August 10, 1996, was similar in nature to the earlier outage. These outages highlight the critical need for communication and cooperation between grid operators and illustrate the increasing pressures that competition is placing on the interconnected transmission grid.

The North America Electric Reliability Council (NERC) is currently working on improved information systems and operating procedures to enhance the ability of system operators to anticipate and respond to the operational complexities associated with increased wholesale competition. These steps will not be fully implemented for 1-2 years and will only have the capability of handling little more than the current level of wholesale transactions reliably. Although the system has managed to avoid cascading outages thus far, at least in the East, there is concern that outages can occur under certain circumstances if the NERC systems and procedures are not put into place relatively soon. Any further increase in the number of bulk power transactions associated with additional wholesale transactions or with the advent of retail competition could generate the need for additional systems and/or procedures. It should also be noted that NERC is a voluntary organization and that compliance with NERC procedures is not formally mandated at this time. Therefore, it is not clear what actions will be taken in the event that a party refuses to take corrective action to relieve flows on another party’s system. This may be likely since power supply agreements are currently based on "contract paths" and do not typically reflect actual power flows.

The development of independent system operators (ISOs) for interconnected transmission systems within various regions can facilitate improved communications and coordinated operations and resolve some of the above problems.[22] There are, however, certain trade-offs associated with ISOs which may have reliability implications. There are also significant obstacles to the development of ISOs, particularly in areas where power pools do not currently exist.[23] ISOs must cover broad regions in order to truly enhance operations. Consequently, the formation of an effective ISO will, for the most part, require agreement among a number of utilities with, in many cases, diverse interests. Such an agreement would require a utility, in conjunction with other utilities, to turn over operational control and planning responsibility for its transmission facilities to an independent third party (the ISO). This would obviously raise a number of complicated issues including: utility compensation for the use of its transmission system; ISO governance; joint planning procedures; construction of jointly planned transmission additions; and issues associated with the functional separation of transmission and generation.

The development of ISOs will also impose additional costs. These costs may be substantial. In fact, initial estimates indicate that it will cost approximately $250 million to establish an ISO and power exchange in California.[24] This initial estimate does not include on-going costs of these systems.

The development of ISOs and transmission unbundling also give rise to the potential loss of certain efficiencies associated with the joint operation and installation of transmission and generation facilities. Utilities have historically added and operated facilities in a manner which was intended to minimize total bulk power costs. Nondiscriminatory transmission access and independent operation of transmission facilities may result in the loss of some of these

efficiencies since it will be very difficult to plan for a least-cost combination of transmission and generation additions in a competitive/ISO structured environment.

Under certain ISO proposals, utilities will continue to own both transmission and generation facilities. Under this type of arrangement, a utility may own generation facilities that have enhanced values that are attributable to transmission constraints. In this instance, a utility may be reluctant to make a good faith commitment to add needed transmission facilities required by the ISO since such an addition may not be in the utility's financial interest. Since the structure of an ISO may effectively prohibit the ISO from owning transmission additions and the ISO may not have the "right of eminent domain" to condemn property, the ISO may be dependent on a utility to construct the needed addition even though the addition is not in that utility's interests. This would increase the difficulties of adding needed transmission facilities; a process that is already extremely difficult.

The functional separation of transmission and generation may also cause operational and scheduling problems as well. The scheduling of maintenance activities may be complicated by such separation since generation can be dispatched to relieve constraints caused by transmission line maintenance. Likewise, transmission systems can be used to deliver electricity to areas normally served by specific generating units during periods when those units are taken off-line for maintenance. Consequently, maintenance schedules must be coordinated to assure reliable service. The competitive interests of generators may not always coincide with transmission maintenance schedules and the ISO may have a limited ability to resolve such conflicts.

Such conflicts require that transmission system operators have some operational control over specific generating facilities at certain times in order to maintain transmission and grid reliability. Such control must be balanced against competitive interests if restructuring is to produce reliable electric supplies at competitive prices. It will be very difficult to achieve an appropriate balance given the dynamic nature of our electric system. In short, the extent to which ISOs control generating facilities could greatly impact the level of actual competition between suppliers. Consequently, the determination of control needed by the ISO could ultimately dictate the success or failure of restructuring.

The separation of generation and transmission facilities also has implications for the certification and siting of such facilities. Deregulation of generation may effectively eliminate public need determinations for new generating facilities since such facilities would be added in response to market signals rather than an administrative determination of need. This has implications for the siting of transmission lines in two respects. First, many transmission lines are built to connect generating facilities to the bulk power grid. In this instance, the location of generating facilities would dictate, in large measure, the location of transmission lines. This could result in either an effective bypass of the public approval process for transmission lines or create even greater financial risk for power plant developers. Second, transmission lines and generating facilities are, as noted earlier, substitutable in certain respects. In some instances, it may be more practical and cost effective to add a generating facility as opposed to a transmission line to relieve local supply constraints.

Deregulation of generation would in effect eliminate obligations to construct generating units and regulators may not have the ability to compel construction of the least cost alternative. This may make it difficult for regulators to approve a transmission line on the basis of public need. Reliability could be impacted if transmission routing approvals are delayed as a result of these siting complications or if the risks of developing generating units are increased.

Jurisdictional Implications of Unbundling

The separation of the various electric utility functions and the deregulation of generation could also have indirect implications for reliability since restructuring may result in a fundamental shift of responsibility and regulatory authority. The FERC acknowledges this prospect but has noted that states will continue to have some oversight authority. In Order No. 888, the FERC notes:

> *Although jurisdictional boundaries may shift as a result of restructuring programs in wholesale and retail markets, we do not believe this will change fundamental state regulatory authorities, including authority to regulate the vast majority of generation asset costs, the siting of generation and transmission facilities, and decisions regarding retail service territories.*[25]

The FERC has also indicated that states will continue to have authority over distribution services. The distinction between distribution and transmission services is, however, not clear. Given the FERC's positions regarding the regulatory authority of state regulatory commissions, states may continue to have some limited ability to assure an adequate supply of electricity. However, the extent of this jurisdiction is also unclear. One certainty is that states will have less oversight and less ability to assure reliability as a result of restructuring.

Despite noting that states will continue to have continued oversight authority, the FERC maintains that it will have authority over retail wheeling services once retail customers are granted access to competitive suppliers. Given the FERC's position, retail wheeling will result in a further transfer of regulatory responsibilities from the states to the FERC. This could mean that regulatory oversight over transmission reliability is largely a FERC responsibility in the future. While this does not necessarily mean that reliability will be negatively impacted, it does raise questions regarding the consideration of local or state interests and creates the possibility that service reliability will be given less focus.

In any event, states will have less authority with respect to assuring reliable electric supplies than they have had in the past. Certain restructuring models may preserve less authority for states than others. For example, a state may only have limited authority to require

the development of a multi-state ISO. Consequently, jurisdictional considerations may influence model preferences if Virginia regulatory involvement in maintaining reliability is found to be desirable.

Distribution

Electric utility restructuring will have fewer reliability implications for distribution than for other functions. Distribution functions will continue to be regulated in much the same manner as they are today, with the potential for greater service quality monitoring. Restructuring could, however, have indirect implications for maintaining distribution service reliability given the jurisdictional uncertainty discussed above and competitive pressures for utilities to cut costs. Thus far, utilities have not limited cost cutting measures to competitive services and have reduced staffing levels across all functions. These measures could adversely affect distribution service quality if austerity measures are extreme. The Commission has recognized this potential and has directed the Staff to evaluate service quality standards. Such standards should help to assure distribution service reliability if adopted and/or serve as a basis for performance based regulation of distribution companies.

Conclusions

Electric utility restructuring may have a number of implications for electric service reliability; both good and bad. Proponents of a rapid movement to retail competition for electricity argue that competitive pressures will cause suppliers to develop new and innovative products and services which will enhance reliability since service quality will be an important consideration for almost all electricity consumers. This may be true over the longer term provided that restructuring policies and initiatives provide both suppliers and consumers with proper incentives and responsibilities.

While restructuring could potentially enhance reliability in the future, there are a number of uncertainties associated with restructuring which could jeopardize reliability if competitive policies are ill-conceived or poorly implemented. In any event, there are a significant number of complicated issues that must be addressed or closely monitored in a transition to a competitive electric industry and it must be recognized that the development of information systems and ISOs will take time. It should also be recognized that the establishment of ISOs and information systems may be costly. These reliability related issues and uncertainties should be considered and addressed, to the extent possible, in the development and implementation of a competitive model. Specific measures for ensuring continued reliability are described in the discussion of market structures.

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[16] Improved gas-fired generating technologies and cogeneration facilities have resulted in generation located nearer to load centers. However, the majority of electrical supplies continue to be produced from large remote central power stations.

[17] New devices are being developed for controlling transmission flows. However, these devices are expensive and are currently being used in only limited circumstances. Load curtailments can also be used to control transmission line loadings.

[18] Adam B. Jaffe and Frank A. Felder, "Should Electricity Markets Have a Capacity Requirement? If So, How Should It Be Priced," The Electricity Journal, December, 1996, at 60.

[19] ELCON, "Competition Can Enhance Bulk-Power Reliability," Profiles on Electricity Issues, Number 19, June, 1997, at 13.

[20]FERC, "Promoting Wholesale Competition Through Open Access Non-discriminatory Transmission Services by Public Utilities; Recovery of Stranded Costs by Public Utilities and Transmitting Utilities," Order No. 888, April 24, 1996.

[21] "Flow of outside power threatens Southern Cos reliability," Restructuring Today, July 22, 1997.

[22] An ISO would assume operational control and planning authority over the transmission facilities owned by its member utilities. In certain instances, ISOs would be structured as non-profit organizations or limited liability corporations and would not be able to actually own transmission facilities.

[23] A power pool typically represents coordinated dispatch, joint planning and shared reserves between a number of non-affiliated utilities. Virginia Power does not currently participate in a power pool. AEP-Virginia, Potomac Edison and Old Dominion Power participate in pooling arrangements with affiliated utilities. Delmarva Power & light is a member of the PJM power pool.

[24] California Public Utilities Commission, "Interim Opinion: ISO and PX Funding," D.96-08-038, August 2, 1996.

[25] FERC, "Promoting Wholesale Competition Through Open Access Non-discriminatory Transmission Services by Public Utilities; Recovery of Stranded Costs by Public Utilities and Transmitting Utilities," Order No. 888, April 24, 1996, at 8.